

POWER SYSTEMS  
RECTIFIER CIRCUIT  
ELECTRON TUBE TYPE - AUTOMATIC REGULATION  
48 VOLTS, 8 AMPERES DC  
J86251A

CHANGES

A. CHANGED AND ADDED FUNCTIONS

A.1 The operate path of the CEMF contactor has been taken through a make contact on the GR relay so that the plant countercell will always be removed during ac power failures.

B. CHANGES IN APPARATUS

B.1	Replaced	Replaced by
	Voltmeter Relay (VR) KS-14397	KS-14783

C. CHANGES IN CIRCUIT REQUIREMENTS OTHER THAN THOSE APPLYING TO ADDED OR REMOVED APPARATUS

C.1 In Circuit Requirements Table, VR, KS-14397 has been rated "Mfr. Disc." and is replaced by KS-14783 to facilitate reading of the voltmeter scale.

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Options "ZA," "ZB," "ZC" and "ZD" were added.

D.2 "ZE" option between CONT. 1 fuse and terminal 12 of TSI was added.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 5233-HMK-DET-EB

POWER SYSTEMS  
RECTIFIER CIRCUIT  
ELECTRON TUBE TYPE - AUTOMATIC REGULATION  
48 VOLTS, 8 AMPERES D.C.  
J86251A

CHANGES

A. CHANGED AND ADDED FUNCTIONS

A.1 "J" wiring option was added at (TS2) of the rectifier to provide Common Fuse and Voltage Alarm With Voltage Alarm Delay.

A.2 Automatic Over Charge Ckt. Fig. 3, was rated "Mfr. Disc."

A.3 "E" wiring option was added to provide an alarm circuit if fuse (REG1) should fail.

B. CHANGES IN APPARATUS

B.1 Added

Terminal Punchings (TP2) and (TP3)

B.2 Replaced

Replaced By

Switch (OVER CHG)  
AUTO-MAN, KS-13674,  
L22 d.p.d.t.

SWITCH (OVER CHG)  
OFF-ON, KS-13674,  
L15 d.p.s.t.

Resistor (R11),  
koolohm 10KT,  
RW56J511, 9W  
-510 ohms

Resistor (R11),  
KS-14603, L2A  
-510 ohms

Varistor (RV1)  
23A

(RV1) KS-15657, L7  
Rectifier Stack

B.3 Removed

Automatic Over Chg. Ckt. - Fig. 3

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Terminal punchings (TP2) and (TP3) were added for use as mounting connectors for resistors (R16) and (R15) respectively.

D.2 With the Automatic Over Chg. Ckt. Fig. 3 rated "Mfr. Disc.", the (Over Chg.) switch was changed to a d.p.s.t. switch.

D.3 Additional circuit information was added to Circuit Notes 101, 102, and 107.

D.4 Circuit Note 108 was added to drawing.

D.5 The ground side of the (L) relay winding was changed to connect to ground through the (TST) switch rather than directly to ground.

D.6 Circuit Note 109 covers the replacement code of resistor (R11).

D.7 The code of (RV1) was changed to agree with manufacturing information.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 5740-AH-CHA-DV

POWER SYSTEMS  
RECTIFIER CIRCUIT  
ELECTRON TUBE TYPE - AUTOMATIC REGULATION  
48 VOLTS, 8 AMPERES D.C.  
J86251A

CHANGES

A. CHANGED AND ADDED FUNCTIONS

A.1 Transformers 363B (T1) and 360AB (T2), as N options, were added to the rectifier for 230 volt a-c power supply operation

B. CHANGES IN APPARATUS

B.1 Added

Transformer (T1) 363B  
Transformer (T2) 360AB  
Resistor (R15) KS-13492 L1  
Resistor (R16) KS-13492 L1

B.2 Replaced Replaced By

Lamp 2Y (Overchg.) Lamp C2 (Overchg.)

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Additional circuit information was added to Circuit Notes 104 & 105 for 230V operation.

D.2 Circuit Note 107 was added to drawing.

D.3 Resistor (R15) was added in series with lamp (HVACO) to reduce applied voltage across lamp.

D.4 Lamp 2Y(Overchg.), a carbon filament type, was superseded by Lamp C2, a tungsten filament type.

D.5 Resistor (R16) was added in series with lamp (Overchg.) to reduce applied voltage across lamp.

D.6 In paragraph 2.1 Working Limits 200-250 Volt 60 Cycles was added.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 5740-AH-CHA-DV

CIRCUIT DESCRIPTION  
SYSTEMS ENGINEERING DEPARTMENT

CD-81138-01  
Issue 2-A  
Appendix 1-A  
Dwg. Issue 4-A

POWER SYSTEMS  
RECTIFIER CIRCUIT  
ELECTRON TUBE TYPE - AUTOMATIC REGULATION  
48 VOLTS - 8 AMPERES D-C  
J86251A

CHANGES

B. CHANGES IN APPARATUS

B.1	Superseded	Superseded By
	KS-13492L1 10,000 ohms (R3)	KS-13492L1 7500 ohms

All other headings, no change

BELL TELEPHONE LABORATORIES, INC.

DEPT. 5740-FWA-DET-DV

POWER SYSTEMS  
RECTIFIER CIRCUIT  
ELECTRON TUBE TYPE - AUTOMATIC REGULATION  
4<sup>A</sup> VOLTS - 8 AMPERES  
J86251A

CHANGES

6. CHANGES IN CIRCUIT REQUIREMENTS  
OTHER THAN THOSE APPLYING TO ADDED  
OR REMOVED APPARATUS

6.1 The (L) relay winding connections  
have been changed. Terminal 7T  
now goes to ground and 7B now goes to  
the "L" contact of the (YR) relay.

All other headings under "Changes," no  
change.

2.2

Float Regulation Variable Condi-  
tion

1 to 8 Amperes Norminal Line  
1 to 8 Amperes  $\pm$  % Change in  
Line V  
8 Amperes  $\pm$ 5% Change in Line V

Max. Resulting Change  
In Output Voltage

$\pm$  1.25%  
 $\pm$  2.5%  
 $\pm$  1.50%

2.3 Charging 4<sup>A</sup> volts, 10 amperes -  
intermittent  
54 volts, 7.5 amperes - continuous  
Room temperatures of 0 to 104F.

circuit: SD-81134-01 4<sup>A</sup>V Charge and  
Discharge Circuit.

DESCRIPTION OF OPERATION

3. FUNCTIONS

3.1 To provide a means for rectifying  
a-c power to filtered d-c supply  
for charging a 24 cell storage battery.  
The rectifier unit will float loads up  
to its continuous rated load of 8 am-  
peres with changes in line voltage not  
exceeding  $\pm$ 5%. For loads above this,  
and without change in adjustment, the  
rectifier will deliver the intermittent  
rating of 10 amperes, but at a reduced  
voltage. If it is desired to fully  
float the battery at all times, the  
load connected to the battery must be  
limited to 8 amperes or supplementary  
rectifier units must be used. However,  
this rectifier unit may be used for  
batteries having variable loads larger  
than 8 amperes if there is sufficient  
time to charge the battery during light  
load periods when the load is less than  
the output of the rectifier. The excess  
load is taken from the battery during  
the heavy load period and no change  
in the adjustment of the rectifier is  
required due to this method of oper-  
ation.

5. INSULATION OF D-C FROM A-C

The power rectifier circuit con-  
sists of a transformer (T1) which fur-  
nishes plate voltage for the rectifier  
tubes (V1) and (V2). Transformer (T2)  
furnishes the filament for the rectifier  
tubes (V1) and (V2) and has an addi-  
tional winding to supply 6.3 volts to  
the time delay relay (TD) and 8.5 volts  
to the varistor (RV-1) and a winding to  
supply 20 volts to the overcharge timer  
(OC).

6. FILTERING AND CURRENT LIMITATION

The d-c output of the rectifier  
unit is filtered by means of a retard-  
ation coil connected in the negative  
charge lead, which is part of the recti-  
fier unit charge circuit. Ballast lamp  
(V3) is used to absorb the excess volt-  
age from the rectifier when operating  
with high line voltage and low battery  
voltage. Ammeter (A) is provided to read  
the charging current.

4. CONNECTING CIRCUITS

4.1 This circuit was designed to in-  
terconnect with the following

7. REGULATION

The regulating circuit consists of  
resistance (R3), rheostat (ADJ VOLTS)  
varistor (RV1) and the grid battery.  
The point between the resistance (R3)

and the rheostat (ADJ VOLTS) is connected to the rectifying tubes through the GRID battery and the resistances (R1) and (R2) by way of the upper contacts 1T-2T of the (GR) relay. The drop across the resistance (R3) is negative with respect to the cathode of the rectifying tubes and the BIAS battery is poled to oppose this voltage sufficiently to allow a net negative voltage of 1 to 3 volts to be applied to the grids of the rectifying tubes. When the battery voltage is at the floating value this negative grid voltage is sufficient to reduce the output of the tube to a small value just sufficient to float the battery. When a load is applied to the battery, its terminal voltage drops slightly and this small change in voltage is reflected over the regulating lead (REG 1 Fuse) to the varistor (RV1), rheostat (ADJ VOLTS) grid battery and resistances (R1) and (R2) to the grids of the tubes, reducing the value of the net negative voltage. With reduced negative voltage the output current of the tubes increase until it is sufficient to return the battery voltage to the floating value. This operation will continue until the load on the battery has reduced the net grid voltage to approximately less than one volt. If the grid voltage is less than one volt, the grids lose control and the tubes carry current during practically their entire cycle and operate in the same manner as the conventional two element tubes. Under this condition, when the load on the battery is equal to the full load capacity of the rectifier or greater, the output current of the rectifier is determined by the battery voltage, transformer secondary voltage, drop over the ballast lamp and the impedance drops in the series charging circuit. The ballast lamp at loads less than full load has a small voltage drop. With loads of 10 amperes the voltage drop increases rapidly and tends to limit the rectifier output current. The resistances (R1) and (R2) limit the grid current to a small value and assist in load regulation.

#### 8. CATHODE PROTECTING TIME DELAY

The relays (GR) and (TD) serve as a time delay to prevent bombardment of the cathodes of the rectifier tubes (V1) and (V2) while their filaments are heating. During the starting period, negative voltage is obtained from the varistor through upper contacts 2 and 3 of the (GR) relay to the grids. This furnishes a negative voltage sheath around the cathode to protect it until the filament has normal emission. At the same time the filament starts to heat and voltage from the 10-11 winding of (T2) is applied through the bottom contacts "2-3" of the (GR) relay to the heater of the (TD) relay. After  $45 \pm 5$  seconds, the (TD)

relay contacts close and operate the (GR) relay, using current from the varistor (RV1). The (GR) relay locks up over its bottom contacts "3-4" which disconnects the heater of the (TD) relay with its bottom "2-3" contacts and transfers the grid from the starting lead on its upper contact "3" to the normal regulating circuit connected to its upper contact "1."

#### 9. VOLTAGE COMPENSATION

The varistor (RV1) condenser (C5) provide a small source of filtered d-c to operate the (GR) relay and also to provide a variable voltage to the grids of the rectifying tubes (V1) and (V2). This compensates for line voltage changes. When the line voltage changes, the small d-c source changes in direct proportion and this fraction of a volt change, reflected through the regulating circuit to the grids of the rectifying tubes is of sufficient magnitude to compensate for the change in the grid characteristics of the tubes due to a change in the plate voltage supply to the tubes. This feature permits the line voltage to change with very little effect on the regulated voltage when the grids of the rectifying tubes have control.

#### 10. POWER FAILURE CONDITION

No adjustments are required after a power failure. If the battery is discharged, the rectifier when the power is restored will charge the battery at a rate between 9 and 11 amperes until the voltage is up to the floating value.

#### 11. RADIO AND CARRIER FREQUENCY FILTERING

The retardation coils (L3) and (L4), condensers (C2), (C3) and (C4) serve to suppress the radio interference generated in the rectifying tubes. Condenser (C1) serves to prevent low radio and carrier frequencies from being induced in the a-c and d-c circuits.

#### 12. GRID BIAS SUPPLY

A 46.5 volt grid battery (3T dry cells) shall be connected to the G+ and C- terminals. It is important to use the correct number of cells in the grid battery. When the battery is new the rheostat (ADJ VOLTS) shall be near the counterclockwise end of its travel (facing the front of the rectifier) and when the rheostat (ADJ VOLTS) is in its maximum clockwise position, it will indicate that the grid battery has aged and should be replaced. Cells should not be added to compensate for decreased battery voltage but the entire battery should be replaced when aged, see BSP 301.303. Regulated metallic type

rectifier units are mechanically interchangeable with specified grid battery.

### 13. VOLTAGE ALARMS

In plants using only one rectifier a high and low voltage alarm signal is provided by the (VR) and (L) relays at terminal 17. If Figure 2 is provided an alarm delay of about 4 minutes is provided. A ground or battery signal is available at terminal 18 with delay and at terminal 17 without delay. The (HV ACO) key when operated removes the high voltage signal path from terminal 14 and lights lamp (HV ACO).

### 14. OVERCHARGE AND TEST

The (CEMF) contactor is provided so that when the (OVERCHG) key is operated to the "MAN" position it inserts a counter EMF cell in the plant discharge circuit, for overcharging the battery. If Figure 3 is provided and the (OVERCHG) key is operated to the "AUTO" position the overcharge time is automatically controlled for periods of approximately 24 hours. With the (TST) SW operated to the "TST" position the (CEMF) contactor operates and the regulating lead is switched from the discharge circuit to the charge circuit so that the plant discharge voltage is reduced about 2 volts for test purposes.

### 15. DISCHARGE CIRCUIT FUSING

Discharge fuses are provided for plant loads. Fuse ratings are specified on the connecting circuit.

### 16. PLANT CONTROL

The voltage drop across the (V3) ballast lamp is available at (TS1) terminals 1 and 2 for plant control. Plant control is also available at terminals 14 (high voltage) and 15 (low voltage). See connecting circuit.

### 17. ADJUSTING THE REGULATING VOLTAGE

The float voltage should be set at 51.6 volts at output currents as indicated below for the line voltage which exists when adjustment is made.

Line Voltage (115V Taps)	Rectifier Unit Output Current Amperes
115 ± 3V	5-7
121 ± 3V	5-7
109 ± 3V	4-5.5

If the plant load at the time of adjustment is less than the appropriate value above allow the battery to discharge by turning the (ADJ VOLTS) rheostat full C.C.W. and maintaining this adjustment until by slowly turning the rheostat clockwise the current output desired will exist when the battery voltage is 51.6 volts.

If the plant load is in excess of the appropriate value above charge the battery by operating the "OVERCHG" key to the "MAN" position until the battery voltage is above 51.6 volts. Return the key to "OFF" position and adjust the rheostat (ADJ VOLTS) until the rectifier output is 51.6 volts when the output current is as indicated in above table.

The rectifier current will in several minutes change to the value required to float the load and the voltage will remain in the floating range if the rectifier output is less than 7 amperes. With larger rectifier output current the voltage will decrease to approximately two volts per cell. Never attempt to adjust the regulated voltage by rheostat (ADJ VOLTS) when the voltage is below 51.6V. The voltage should be checked again at suitable intervals and the regulated voltage adjusted as described above if necessary. When checking the regulated voltage be sure that the rectifier output is between 4 and 7 amperes and that line voltage is considered.

The life of the grid battery should be at least two years from its date of manufacture. See BSP 301.303. After a new battery is installed there might be a slight increase in the regulated voltage which will decrease with time. When regulated voltage decreases, the rheostat (ADJ VOLTS) should be turned in a clockwise direction to bring the voltage up to the floating value.

If the regulating circuit is functioning a counterclockwise rotation of the rheostat (ADJ VOLTS) will always reduce the rectifier output current to approximately no load or operation of "OVERCHG" key will cause the output current to increase to its maximum value.

BELL TELEPHONE LABORATORIES, INC.

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